



**[4910-13]**

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**14 CFR Part 33**

**[Docket No. FAA-2014-0637; Special Conditions No. 33-015-SC]**

**Special Conditions: CFM International, LEAP-1A and -1C Engine Models; Incorporation of Woven Composite Fan Blades**

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Final special conditions.

**SUMMARY:** These special conditions are issued for the CFM International (CFM), LEAP-1A and -1C engine models. These engine models will have a novel or unusual design feature associated with the engine fan blades—new woven composite fan blades. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

**DATES:** Effective **[Insert date 30 days after date of publication in the Federal Register]**.

**FOR FURTHER INFORMATION CONTACT:** For technical questions concerning this action, contact Alan Strom, ANE-111, Engine and Propeller Directorate, Aircraft Certification Service, 12 New England Executive Park, Burlington, Massachusetts, 01803; telephone (781) 238-7143; facsimile (781) 238-7199; e-mail [alan.strom@faa.gov](mailto:alan.strom@faa.gov).

For legal questions concerning this action, contact Vincent Bennett, ANE-7, Engine and Propeller Directorate, Aircraft Certification Service, 12 New England Executive Park, Burlington, Massachusetts, 01803; telephone (781) 238-7044; facsimile (781) 238-7055; e-mail [vincent.bennett@faa.gov](mailto:vincent.bennett@faa.gov).

## **SUPPLEMENTARY INFORMATION:**

### **Background**

On June 27, 2012, CFM International (CFM) applied for a type certificate for their new LEAP-1A and -1C engine models. The LEAP engine models are high-bypass-ratio engines that incorporate a novel and unusual design feature—new woven composite fan blades. The woven composite fan blades will have significant differences in material property characteristics when compared to conventionally designed fan blades using non-composite metallic materials.

Special conditions are required to ensure that the LEAP-1A and -1C woven composite design fan blades account for the differences in material properties and failure modes relative to conventional single-load path metallic blades. In addition, different containment requirements may be applied provided CFM shows that the blade design below the inner annulus flow path line provides multiple load paths and crack arresting features that prevent delamination or crack propagation to blade failure during the life of the blade.

These special conditions are necessary because the applicable airworthiness regulations do not contain adequate or appropriate safety standards for the new woven composite design fan blades.

## **Type Certification Basis**

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, CFM must show that the LEAP-1A and -1C engine models meet the applicable provisions of the applicable regulations in effect on the date of application, except as detailed in paragraphs 21.101(b) and (c). The FAA has determined the following certification basis for the LEAP-1A and -1C engine models:

1. 14 CFR part 33, “Airworthiness Standards: Aircraft Engines,” dated February 1, 1965, with Amendments 33-1 through 33-32, dated September 20, 2012.

If the FAA finds that the regulations in effect on the date of the application for the change do not provide adequate or appropriate safety standards for the LEAP-1A and -1C engine models because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the engine model for which they are issued. Should the type certificate for that engine model be amended later to include any other engine model that incorporates the same novel or unusual design feature, the special conditions would also apply to the other engine model under § 21.101.

In addition to complying with the applicable product airworthiness regulations and special conditions, the LEAP-1A and -1C engine models must comply with the fuel venting and exhaust emission requirements of 14 CFR part 34.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type-certification basis under § 21.17(a)(2).

## **Novel or Unusual Design Features**

The LEAP–1A and –1C engine models will incorporate the following novel or unusual design feature:

The LEAP–1A and –1C engine models will incorporate woven composite fan blades. The woven composite fan blades will have significant differences in material property characteristics when compared to conventionally designed fan blades using non-composite metallic materials. Composite material design provides the capability to incorporate multiple load paths and crack arresting features that prevent delamination or crack propagation to blade failure during the life of the blade.

The woven composite fan blades are a novel and unusual design feature that requires additional airworthiness standards for type certification of the LEAP–1A and –1C engine models.

## **Discussion of Comments**

A notice of proposed special conditions, No. 33–14–02–SC, for the CFM LEAP–1A and –1C engine models was published in the Federal Register on Friday, November 14, 2014 (79 FR 68137). No comments were received and the special conditions are adopted as proposed.

## **Applicability**

As discussed above, these special conditions are applicable to the LEAP –1A and –1C engine models. Should CFM apply at a later date for a change to the type certificate to include another model on the same type certificate incorporating the same novel or unusual design feature, the special conditions would apply to that model as well.

## **Conclusion**

This action affects only certain novel or unusual design features on LEAP– 1A and –1C engine models. It is not a rule of general applicability and applies only to CFM, who requested FAA approval of this engine feature.

## **List of Subjects in 14 CFR Part 33**

Aircraft, Engines, Aviation Safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

## **The Special Conditions**

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for CFM LEAP–1A and –1C engine models.

### **1. Part 33, Requirements.**

In addition to the airworthiness standards in 14 CFR part 33, effective February 1, 1965, with Amendments 33–1 through 33–32 applicable to the LEAP–1A and –1C engine models, CFM will:

- (a) Conduct an engine fan blade containment test with the fan blade failing at the inner annulus flow path line instead of at the outermost retention groove.
- (b) Substantiate by test and analysis, or other methods acceptable to the FAA, that a fan disk and fan blade retention system with minimum material properties can withstand, without failure, a centrifugal load equal to two times the maximum load the retention system could experience within approved engine operating limitations. The fan blade retention system includes the

portion of the fan blade from the inner annulus flow path line inward to the blade dovetail, the blade retention components, and the fan disk and fan blade attachment features.

(c) Using a procedure approved by the FAA, establish an operating limitation that specifies the maximum allowable number of start-stop stress cycles for the fan blade retention system. The life evaluation must include the combined effects of high-cycle and low-cycle fatigue. If the operating limitation is less than 100,000 cycles, that limitation must be specified in Chapter 5 of the Engine Manual Airworthiness Limitations Section. The procedure used to establish the maximum allowable number of start-stop stress cycles for the fan blade retention system will incorporate the integrity requirements in paragraphs (c)(1), (c)(2), and (c)(3) of these special conditions for the fan blade retention system.

(1) An engineering plan, which establishes and maintains that the combinations of loads, material properties, environmental influences, and operating conditions, including the effects of parts influencing these parameters, are well known or predictable through validated analysis, test, or service experience.

(2) A manufacturing plan that identifies the specific manufacturing constraints necessary to consistently produce the fan blade retention system with the attributes required by the engineering plan.

(3) A service management plan that defines in-service processes for maintenance and repair of the fan blade retention system, which will maintain attributes consistent with those required by the engineering plan.

(d) Substantiate by test and analysis, or other methods acceptable to the FAA, that the blade design below the inner annulus flow path line provides multiple load paths and crack arresting

features that prevent delamination or crack propagation to blade failure during the life of the blade.

(e) Substantiate that during the service life of the engine, the total probability of an individual blade retention system failure resulting from all possible causes, as defined in § 33.75, will be extremely improbable with a cumulative calculated probability of failure of less than  $10^{-9}$  per engine flight hour.

(f) Substantiate by test or analysis that not only will the engine continue to meet the requirements of § 33.75 following a lightning strike on the composite fan blade structure, but that the lightning strike will not cause damage to the fan blades that would prevent continued safe operation of the affected engine.

(g) Account for the effects of in-service deterioration, manufacturing variations, minimum material properties, and environmental effects during the tests and analyses required by paragraphs (a), (b), (c), (d), (e), and (f) of these special conditions.

(h) Propose fleet leader monitoring and field sampling programs that will monitor the effects of engine fan blade usage and fan blade retention system integrity.

(i) Mark each fan blade legibly and permanently with a part number and a serial number.

Issued in Burlington, Massachusetts, on June 1, 2015.

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Aircraft Certification Service

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